Point-Nonpoint Source Trading Summary

Finalized For Rahr Malting Permit On January 8, 1997

Executive Summary

The Minnesota Pollution Control Agency (MPCA) welcomes the opportunity to resolve the issue associated with Rahr Malting Company's proposed discharge to the Minnesota River in an innovative manner that provides flexibility to the Permittee while ensuring a degree of water quality protection that is equal to or better than that which would have resulted from a more traditional approach. The substitution of upstream nonpoint source pollutant loading reductions for at-plant Biochemical Oxygen Demand discharge loading addresses the problem of dissolved oxygen sag in the lower reach, while providing additional water quality benefits both upstream and downstream of the Total Maximum Daily Load zone. The agreement described above meets the basic guidelines for pollutant reduction trading developed by the Water Quality Division as well as the U.S. Environmental Protection Agency's (EPA) Draft Framework for Watershed Based Trading. The funds provided by Rahr Malting appear to be sufficient to obtain the specified reductions in nonpoint source pollutant loading, provided that best management practices (BMPs) are selected and sited using the methodology prescribed in the Nonpoint Source Trade Crediting Calculations document, and care is taken not to overcompensate landowners for implementing BMPs.

Introduction

Rahr Malting Company has proposed to combine at-plant limits on phosphorus and Carbonaceous Biochemical Oxygen Demand as determined by the five day test ($CBOD_5$) with point-nonpoint source pollutant reduction trades. These two approaches are targeted to provide adequate treatment of the waste loads to remain within the requirements of the 1985 (amended 1987) Waste Load Allocation for the lower Minnesota River. The Rahr wastewater currently is being treated at the Metropolitan Council Environmental Services Blue Lake wastewater treatment plant (Blue Lake). Rahr wishes to control future wastewater treatment operation costs while providing a beneficial reuse of the sludge associated with only the malting process (not domestic waste) by treating the process wastewater in a separate system and discharging the effluent into the lower Minnesota River.

Background

The EPA and the Minnesota Pollution Control Agency established a Total Maximum Daily Load (TMDL) for Biochemical Oxygen Demand (BOD) at the Minnesota River below river mile 25. The TMDL was established in 1988 for the seven-day, ten-year low flow (7Q10) and is set at 53,400 pounds per day of CBOD ultimate. Many factors contribute to the oxygen demand of the river in this reach. The following is a list of significant contributors to the demand:
a) metropolitan wastewater treatment plants (WWTP) loading; b) upstream loading from the River; c) loading from tributaries to the Minnesota River below river mile 25; d) sediment

oxygen demand; and e) nitrogenous oxygen demand. Two of these are of direct relevance to the Rahr request for a discharge permit:

- The first is the loading of oxygen demand generated upstream of river mile 25. This loading comes from other municipal WWTP discharges and nonpoint sources of nutrients which generate biological productivity and sediment uptake of oxygen.

- The second is the metropolitan wastewater treatment plants (WWTP) of Blue Lake and Seneca which discharge into the TMDL reach of the Minnesota River. These plants are not operating at their capacity. It may take years for the WWTPs to reach design loads. MPCA staff estimates conservatively a ten-year window exists before the total loading allocated to Blue Lake WWTP will be utilized at the current rate of growth after Rahr's discharge is removed. Until this time, the BOD loading from the proposed Rahr treatment facility would fall well within the amount authorized by the TMDL.

Complicating the use of the TMDL is how the BOD has traditionally been allocated to point source and nonpoint discharges upstream. A wastewater treatment plant discharge has an organic load which is assumed to be treated by the assimilation process which exists in nature. The treatment plant's impact studied to determine discharge limits have concentrated on the local reach. However, investigations indicate that during low flow periods, the River is overloaded with a BOD load from upstream which impacts the lower reach. The river is most vulnerable to BOD loading during low flows.

To address this, a paper by Erwin Van Nieuwenhuyse, Ph.D., formerly of the MPCA, documented the association of nutrients, specifically phosphorus, with chlorophyll concentrations in rivers world wide. This provides the foundation for river eutrophication similar to lake eutrophication data linking phosphorus and chlorophyll. The paper also focused specifically on the relationship between chlorophyll and BOD in the Minnesota River finding a strong correlation. This concept of nutrient load to chlorophyll to BOD is significant to all BOD related loading studies. The nutrient loading from discharges and nonpoint sources convert into a BOD load as the biology takes in the nutrient, then grows and then dies, extending the length downstream of a source's BOD impact.

This is important when considering BOD loading demands in a river. ***All*** sources of nutrients upstream are uptaken by algae and other plant growth, and then can exert a BOD demand in the lower reach as the algae dies and decays. Hence, nature is constantly converting nutrients into organic material and organic material back into available nutrients while exerting an oxygen demand.

The impact of the nutrient conversion to organic material and then algae to a BOD load is increased when the river slows down and deposits of organic material are allowed to build up in one location, as is the case of the Minnesota River in the metropolitan area. If the river flows sufficiently to maintain a flushing process, the BOD load is minimized. However, during lower flows, the organic loading builds up in a section of the river and exceeds the assimilation capability in that reach. The foundation of trading then is a reduction of a persistent nutrient loading upstream, such as phosphorus, which accomplish reductions in oxygen demand in the lower reach of the Minnesota River.

MPCA has used Dr. Van Nieuwenhuyse's paper for a basis to evaluate the projected relationship between phosphorus and BOD for the Minnesota River. MPCA staff estimates that one pound of phosphorus is equal to eight pounds of BOD at the city of Jordan. The relationship between phosphorus and BOD is variable dependent on the nutrient needs of the biological life forms, flows, turbidity impacts on photosynthetic activity and the bio-availability of phosphorus. In upstream reaches where phosphorus is considered the limiting growth factor, one pound of phosphorus could generate 17 pounds of BOD based on average stream value correlations. In contrast, as the river proceeds through the metropolitan area, phosphorus is so abundant that significant reductions will be necessary before the nutrient again becomes the most limiting factor in algae growth.

Nitrogen exerts an oxygen demand in a similar manner. Based on stoichiometry, each pound of total Kjeldahl nitrogen (organic nitrogen plus ammonia) requires 4.6 pounds of oxygen to be assimilated. Because nitrogen can be lost to the atmosphere as nitrogen gas, it is less persistent in the river system. Also, the oxygen demand from nitrogen is generally exerted more rapidly than the phosphorus-related oxygen demand from a given nutrient source.

The travel time of the river also must be considered. Algal cells produced in the metropolitan area travel downstream before exerting the oxygen demand in the Mississippi River, where as the algal cells produced upstream exert their oxygen demand on the metropolitan reach. Therefore, reductions in phosphorus in the Minnesota River upstream of Jordan have a higher BOD to Phosphorus ratio, and at the same time, will help to minimize the overabundance of phosphorus in the reaches below the metropolitan WWTPs.

<u>**Concept of Point - Nonpoint Source Trading**</u>

Point-nonpoint source (P-NPS) pollutant trading refers to the substitution of nonpoint source pollutant load reductions for point source pollutant load discharge requirements by a discharger permitted under the National Pollutant Discharge Elimination System (NPDES). To meet the TMDL goals, Rahr Malting will treat its effluent discharge beyond what the MPCA would propose and participate in P-NPS trading. MPCA will require that such trades result in pollutant reductions that are:

- Equivalent to the point source discharge in their water quality impact. Equivalence refers to the physical substitution of nonpoint reductions traded for point source loads, taking into account all relevant factors, for example, differences in time, place and chemical form of point and nonpoint source loadings and the sensitivity of the receiving water. In this trade it has been determined that sufficient safety factors for nonpoint BMP's are in place to meet this definition.

- Additional to NPS reductions that would be likely to occur in the absence of a trade. Additionality requires that nonpoint source load reductions that are credited to a point source in a P-NPS trade would not have occurred otherwise, in the absence of P-NPS trading. For example, in this trade feedlot corrections or conservation tillage are not allowable trade credits because there is a regulatory program for feedlots and a cultural trend of adoption of conservation tillage already existing.
- Accountable so that the NPS measures proposed in the trade will be implemented and maintained to achieve their intended result on water quality. Accountability refers to the need to ensure that a P-NPS trade satisfies the above criteria of equivalence and additionality, and that terms of the trade agreement are being lived up to. Only the nonpoint source BMP's verifiable by field inspections or other physical measures have been selected.

A framework for P-NPS trading has been developed for the Rahr Malting permit. In order to implement P-NPS trades, the following definition of what constitutes a trade has been developed.

Trade: A trade is a direct reduction in NPS load which is applied against Rahr Malting's point source load. Trading parameters have been identified for phosphorus, nitrogen, BOD and sediment. In order to address the relative persistence of these compounds in the river system and the spatial variability of BMP sites, NPS load reductions are converted to pollutant reductions using the following conversion ratios:

Table 1

Trade Parameter	Measured Value	Metro Reach BMP $CBOD_5$ Credit	Upstream BMP $CBOD_5$ Credit
Phosphorus	1 pound	8 units	8 units
$CBOD_5$	1 pound	1 unit	Determined by Table 2
Nitrogen	1 pound	4 units	1 unit
Sediment	1 ton	0.5 units	0.5 units

Exertion of oxygen demand within the river system from NPS BOD loading is highly variable, depending on the location of the NPS loading, the river flow, and the velocity. Within the TMDL zone, 1 pound of $CBOD_5$ will be credited at 1 unit. A "BOD trading zone," which extends upstream from the TMDL to river mile 107, or equivalent tributary distances, has been established based on the exertion of BOD oxygen demand during the 7-day 10-year low flow (7Q10). Upstream of the "BOD trading zone," minimal trading credit will be given for $CBOD_5$ reductions since most of this oxygen demand will have already been exerted prior to the TMDL zone. A trade credit of one percent of the pounds removed is credited. Table 2 determines the calculated percent remaining BOD credits.

To satisfy the criterion of equivalence in the case of Rahr Malting, then, it will be necessary to identify types and quantities of BMPs that can be expected to achieve the necessary NPS reduction to remain within the Waste Load Allocation.

Table 2.

River Mile	CBOD5 Percent Remainin	Miles Shakopee
25	100%	0
26	96%	1
27	93%	2
28	91%	3
29	89%	4
30	86%	5
31	84%	6
32	82%	7
33	80%	8
34	77%	9
35	75%	10
36	73%	11
37	71%	12
38	70%	13
39	68%	14
40	66%	15
41	64%	16
42	62%	17
43	61%	18
44	59%	19
45	58%	20
46	56%	21
47	55%	22
48	53%	23
49	52%	24
50	50%	25
51	49%	26
52	48%	27
53	46%	28
54	45%	29
55	44%	30
56	43%	31
57	42%	32
58	41%	33
59	40%	34
60	38%	35
61	37%	36
62	36%	37
63	35%	38
64	35%	39
65	34%	40
66	33%	41
67	32%	42
68	31%	43
69	30%	44

River Mile	CBOD5 Percent Remaining	Miles Shakopee
70	29%	45
71	29%	46
72	28%	47
73	27%	48
74	26%	49
75	26%	50
76	25%	51
77	24%	52
78	24%	53
79	23%	54
80	22%	55
81	22%	56
82	21%	57
83	21%	58
84	20%	59
85	20%	60
86	19%	61
87	19%	62
88	18%	63
89	18%	64
90	17%	65
91	17%	66
92	16%	67
93	16%	68
94	15%	69
95	15%	70
96	15%	71
97	14%	72
98	14%	73
99	13%	74
100	13%	75
101	13%	76
102	12%	77
103	12%	78
104	12%	79
105	11%	80
106	11%	81
107	11%	82
>107	1%	>82

Minimization of Associated Risks

The use of nonpoint source BMPs to trade for a controlled point source discharge does pose some risk. The effectiveness of BMPs in reducing NPS loading depends on the type of BMP selected, its location on the landscape, and the quality of its design and maintenance. It also depends on weather. BMPs are effective during normal storm events and may not operate during drought or extreme storms. Risks associated with BMP implementation will be reduced by conservative estimates of pollutant credit units. Specific examples include:

- The phosphorus to BOD crediting ratio will be 1:8 for the life of the BMP site. This is based on current estimates of the ratio at the city of Jordan, MN. The ratio increases upstream of Jordan, and the ecoregion mean estimates are closer to 1:17. As the Minnesota River is cleaned up, the actual ratio should move toward the ecoregion values.

- In calculating phosphorus loading from soil erosion, conservative estimates of the soil phosphorus content are used. In the event that site-specific soil sampling justifies a higher phosphorus content, a safety factor of 0.75 will be used in the crediting calculations.

- The maximum credit for nitrogen is 1:4 in the TMDL zone. The actual oxygen demand associated with the nitrogen loading is 4.6 pounds of oxygen per pound of TKN.

- Calculation of nitrogen will assume a "field loss factor" of 50 percent to account for ammonia volatilization and nitrogen assimilation prior to transport into the surface water.

- A delivery ratio (DR) of 100 percent for NPS in the riparian zone will be used. However, a DR of 20 percent will be used for lands within a one-quarter mile of the stream and a DR of ten percent will be used for areas further away. These DRs are highly conservative on sites being targeted in this process.

- Land locked areas and watershed divides within larger BMP sites will be factored out of the pollutant credit calculations.

To ensure the appropriate use of these ranges by Rahr, site visits by MPCA staff are to be coupled with communications with the Soil and Water Conservation District staff during the selection process. These factors are multiplicative in the equations used. The conservative nature of the numbers for phosphorus per ton and delivery ratios will result in underestimating the phosphorus reduced by at least a factor of two on "typical" sites. It is, therefore, important to have many sites in the trade so that "typical" conditions are the normal occurrence.

To make a final selection of BMPs, it is necessary to go beyond the question of equivalence to address the criteria of additionally and accountability. Which combination of BMPs would result in pollutant reductions that probably would not have occurred in the absence of trading? Which BMPs most lend themselves to accountability? That is, for which ones would installation,

effectiveness and maintenance be easiest to confirm? What type of BMP could be implemented through the fewest possible number of enforceable contracts with landowners?
Any currently regulated practice cannot be used in the trade as the permitting program would require the change anyway. Some BMPs, such as reduced tillage, are being widely adopted because they make economic sense, and further adoption is likely with or without payments from a trade. Trading eligible BMPs that have been identified to date include:

1. **Soil Erosion BMPs**, including sheet, rill and ephemeral gully erosion, gully erosion, stream, river, and ditch bank erosion.
2. **Livestock Exclusion**, separating livestock from waterways for protection against bank erosion and direct manure impacts.
3. **Rotational Grazing With Livestock Exclusion**, to enhance forages for pollutant reductions from filtering processes and plant nutrient uptake.
4. **Critical Area Set Aside**, of highly erodible land.
5. **Wetland Treatment Systems**, for nutrient removal.

As trading practices become adopted on a more widespread basis, it is likely that additional BMP categories will be identified. These additional BMP categories can be added to the list during permit reissuance or a permit modification.

There are many alternative ways of achieving the required NPS load reduction. To evaluate the effectiveness and cost of some of the most promising BMPs, the MPCA has used a newly developed system of BMP crediting that estimates the reductions in NPS loading that can be expected to result from the implementation of BMPs.

Soil Erosion BMPs

Sources of sediment, nitrogen, phosphorus and BOD occur naturally throughout the basin. The transport of these pollutants to the river is accelerated by intensive land use management such as roads, drainage, construction activities and agricultural practices. In addition, some land use activities provide increased sources of nutrients for vegetative needs such as cropping or lawns. The BMP Soil Erosion crediting system is based on established programs. The first is soil erosion protection. The U.S. Department of Agriculture Natural Resource Conservation Service (NRCS) has been successful in defining soil movement from sheet and rill formations with the use of an equation which is based on soil type, field slope, length of slope, vegetation, and management practices. The Universal Soil Loss Equation, as it is called, is used to predict the erosion tons generated at the field in tons per acre per year. For large gullies or bank erosion, soil loss is estimated by calculating the area which has been eroded divided by the number of years during which the process took place. Once the volume has been established by either of these methods, a conservative value of nutrient content of the soil is calculated. Then a coefficient is used to conservatively estimate how much of the field or bank erosion is transported to the nearest surface water.

Livestock Exclusion

The increased density of animals for agricultural production can also increase the NPS loading associated with storm runoff. The elimination of direct deposits of manure in the riparian zone and bank erosion from animal traffic can be credited. The riparian zone typically has higher delivery ratios associated with it due to its proximity to the water body. The estimated time, number of animals and manure produced is necessary to credit the existing scenario changes in delivery when the animals are no longer allowed access. Likewise, the current bank erosion recession rates are used to estimate future protection provided by stabilizing the current bank and preventing future access.

Rotational Grazing With Livestock Exclusion

Pastured areas not currently classified as feedlots may still contribute significant loads of nutrients, $CBOD_5$ and sediment. The MPCA has a feedlot permitting process for sites where animals are concentrated to such an extent that natural vegetation is destroyed. However, most existing animal grazing systems which maintain vegetation can greatly reduce the delivery of manure to the water. Livestock exclusion when combined with rotational grazing and the use of buffers or easements can be practiced to lower the amount of nutrient impacts on the water body. To estimate this process, the number of animals, the manure content and the time spent in relation to the water is all estimated for the before conditions. This is then compared with the post conditions where the time spent in close relation to the water is eliminated. Delivery of manure volumes from each "paddock" can then be compared with each scenario to predict whole farm reductions of manure delivered to the water. In addition, the management scenarios need to estimate the time the animals occupy each paddock or area of the pasture to rotate the animals sufficiently to prevent a "feedlot" situation and improve the quality of the vegetative stand. The water quality benefit comes from combinations of: a) improved rotation management providing a better forage, improved nutrient uptake as the plant is in a growth phase and added soil cover; b) the use of vegetative filter strips which separate livestock from the water and filter sediment and associated nutrients in runoff; and c) the dispersion of manure throughout the pasture providing more opportunities for nutrient uptake due to proximity of the upper end of the pasture and the water body.

Critical Area Set Aside

Critical area set aside refers to the conversion of land use practices in areas which are excessively vulnerable to soil erosion. Traditional soil conservation sites have been steep sloped bluffs or hills, where removal of vegetation or plowing of soil had greatly accelerated the erosion rate. Combining this concept with criteria that is concerned with the proximity to a hydraulic system that delivers the eroded soil to the river will allow small changes in vegetative management, or bio-engineering to provide large protective savings in river load. The targeting of riparian corridors, steep slopes directly connected to the river, and restoring previously drained isolated wetlands, all fit into this category.

Wetland Treatment Systems

The construction of wetland treatment systems specifically for water quality enhancement defines the wetland treatment system nonpoint source trading BMPs. Wetlands are a valuable watershed management tool in any basin. Wetlands help stabilized hydraulic peaks, provide necessary habitat for the many species critical to the food chain and settle sediments out of the runoff. However, not all wetlands remove nutrient loading from the watershed. Some wetlands act as sinks for phosphorus much of the year only to pulse the mass of nutrients stored out during stressful times such as after drought periods or snow melt. The constructed wetland treatment system is designed to control the way the nutrients are captured and stored or converted so that the mass of nutrients are not available to be released downstream. By maximizing optimum depths, surface area and detention time, criteria nitrogen is volatilized off to the atmosphere, while the phosphorus is captured and buried. This type of wetland may limit some types of habitat use, but is targeted specifically for chemical and sediment treatment.

Structure of the Trade Agreement

The Rahr Malting Company will achieve $CBOD_5$ nonpoint source load reduction by setting up a fund dedicated to projects that encourage adoption of nonpoint source reduction practices. The trust fund will have a board of citizens made up of people concerned with water quality conservation from grass roots organizations, state offices and Rahr representatives who will oversee the selection of BMP sites for trading. MPCA approval is required for all selected sites and the use of the pollutant reduction estimates. All pollutant reduction estimation will follow the formulas in the document entitled: Nonpoint Source Trade Crediting Calculations. The trust fund will be established with $200,000 up front and be augmented by $50,000 over the permit life. Additional members may be added to the board if other contributors wish to add to the trust fund.

Rahr Malting Company's NPDES permit contains the following:

1. A permit limit which authorizes a maximum monthly average discharge up to a 150 pounds per day of $CBOD_5$.

2. The Permittee has accepted a phosphorus limit of 2 mg/l instead of the 3 mg/l limit MPCA would otherwise propose at this time. Due to this, a 30 unit credit may be applied to the cumulative load reduction during the year 2001 and subsequent years provided the Permittee's phosphorus limit remains 2 mg/l or less. In addition, up to 10 units of the phosphorus credit may be used in either 1998, 1999 or 2000 for permit compliance purposes to satisfy any shortfall in that year's nonpoint source load reduction requirement. The Permittee has accepted a year round $CBOD_5$ limit of 12 mg/l instead of the limit MPCA would otherwise propose at this time of 12 mg/l $CBOD_5$ from June through September and 25 mg/l $CBOD_5$ from October through May. Due to this, a 30 unit credit may be applied to the cumulative value for the year 2001 and subsequent years provided the Permittee's year round $CBOD_5$ limit remains 12 mg/l or less.

Other Trade Values Exist

A trade of nonpoint controls to mitigate for point source BOD discharges has several other valuable contributions to the environment. This trade was set up considering primarily the NPS contribution to the reduction goals of BOD in the metropolitan area of the Minnesota River. In addition, NPS reductions from the Minnesota River are an essential part of the emerging strategy to improve the water quality of Lake Pepin on the Mississippi River. Both upstream and downstream improvements in non-metro counties will contribute to the achievement of important water quality goals, and are valuable side benefits of the trade. Basin planning allows for the right blend of conservation adoption and economic growth. This trade has a high potential to make that blend happen.

In addition, the Rahr trade is a pioneering agreement which could help Minnesota break new ground in environmental protection. It provides a flexible means of compliance for the Permittee, and allows industrial expansion to proceed while ensuring a degree of water quality protection that is equal to or better than that which could have resulted from a more traditional approach. Lessons learned from this experience could lead to significant improvements in water quality protection programs.